IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	RICHAUD, Johan L. et al.
Title	RIPPLED SURFACE STOPPER ROD SYSTEM
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AMENDMENT PURSUANT TO 37 C.F.R. § 1.312

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In view of the Notice of Allowance and Fee(s) Due mailed on April 13, 2009, applicants request the amendment of Paragraphs [0006], [0009], [0010], [0011] and [0027] in the specification. Replacement paragraphs [0006], [0009], [0010], [0011] and [0027], marked to indicate changes, are provided herewith.

[0006] However, the use of rugged ~~surcidees~~ surfaces as taught by Japan. Pat. 620895 leads to poor regulation of the metal flow, as aperture size is not a smooth function of the separation between the nozzle bore and the stopper nose. This rugged geometry also causes problems in sealing between the stopper nose and the nozzle bore when it is necessary to shut-off the metal flow because the recesses in the rugged surfaces are by-passed by the liquid metal flow thus entrapping liquid metal in the recesses where it can clog the flow by freezing.

[0009] The present invention provides a stopper rod system for use in a metallurgical vessel. The stopper rod system comprises a stopper rod having a nose on one end thereof, and a nozzle having a bore therethrough, the bore having an internal surface. The stopper rod nose and the internal surface of the nozzle bore have a point of contact when the stopper rod system is in a closed position. At least one of the stopper rod nose and the internal surface of the nozzle bore comprises a plurality of ripples that are arranged such that the size of a flow channel between the stopper rod nose and the internal stopper rod when the stopper rod system is ~~In~~ in an open position discontinuously increases in size as a function of the distance downstream from the point of contact.

[0010] Another embodiment of the present invention provides stopper rod for use in a stopper rod system. The stopper rod system comprises the stopper rod having a nose on one end thereof, and a nozzle having a bore therethrough, the bore having an internal surface. The stopper rod nose and the internal surface of the nozzle bore have a point of contact when the stopper rod system is in a closed position. The stopper rod nose comprises a plurality of ripples that are arranged such that the size of a flow channel between the stopper rod nose and the internal stopper rod when the stopper rod system is ~~In~~ in an open position discontinuously increases in size as a function of the distance downstream from the point of contact.

[0011] Another embodiment of the present invention provides nozzle for use in a stopper rod system. The stopper rod system comprises a stopper rod having a nose on ~~on~~ one end thereof and the nozzle having a bore therethrough, the bore having an internal surface. The stopper rod nose and the internal surface of the nozzle bore have a point of contact when the stopper rod system is in a closed position. The nozzle comprises a plurality of ripples that are arranged such that the

size of a flow channel between the stopper rod nose and the internal stopper rod when the stopper rod system is in an open position discontinuously increases in size as a function of the distance downstream from the point of contact.

[0027] Attention is now drawn to FIG. 5, which illustrates one embodiment of [[∈]] a system of the present invention. Stopper rod nose 42 and outlet nozzle bore 43 shown are shown in a closed position. At point of contact 44, a tangent line 45 has been drawn tangent to the stopper nose surface and extending downstream from the contact point. The variation of the distance between tangent line 45 and stopper rod nose 42 downstream of contact point 45 is illustrated by the lines perpendicular to tangent line 45. Lines 47, 48, 49, and 50 are a series of such perpendicular lines at sequentially increasing distance from point 44. These lines illustrate that in this embodiment of the present invention, the surface of the stopper rod nose 42 comprises a plurality of depressions or ripples. The ripples are shaped so as to form a flow channel between the tangent line and the stopper rod nose 42 that progressively increases in size, but in a step-wise or discontinuous manner, as the distance downstream from the contact point 44 increases.